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ABSTRACT

While it is often assumed that a single mechanism underlies varied experimental evidences of selectivity, Berlyne (1969) suggested that attention-like selectivity may take place in a number of quite separate neural systems. This study examined the issue of visuospatial attention by investigating covert orientation or "looking out of the corner of the eye." In a total of 12 experiments, the same 12 subjects faced a video screen containing 5 squares in a horizontal row. With visual fixation maintained in the center, subjects responded rapidly with a manual key-press to a target stimulus appearing at any time in any square. On each trial, the target stimulus was preceded by a stimulus designed to engage one of three types of covert orientation: reflexive orienting, learned orienting, or voluntary orienting. Separateness of the mechanisms underlying these three processes was hypothesized. The results revealed that, while no single mechanism by itself could be divided, any two different types could move to the left or right simultaneously, indicating a separateness and independence of underlying neural mechanisms. These findings suggest that visuospatial attention is better conceptualized as a class of phenomena than as a single entity. (NB)

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VISUOSPATIAL ORIENTATIONAL SHIFTS: EVIDENCE FOR THREE INDEPENDENT MECHANISMS

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VISUOSPATIAL ORIENTATIONAL SHIFTS: EVIDENCE FOR THREE INDEPENDENT MECHANISMS

Michael Noonan and Seymour Axelrod

Berlyne (1969) cautioned against the assumption that all attentional processes are underlain by a common mechanism. He suggested that attention-like selectivity may take place in a number of quite separate neural systems. Yet this possibility is rarely recognized, most workers appearing to assume that a single mechanism underlies varied experimental evidences of selectivity.

Our interest is in "visuospatial attention," studied in its purest form -- de-coupled from direction of gaze; such covert orienting is referred to in lay terms as "looking out of the corner of the eye." We question the assumption that a single mechanism underlies all instances of covert orienting.

Covert orientation lowers reaction-times (RTs) to target stimuli (TSs) presented at an oriented-to locus compared to RTs to TSs at the same locus when orienting is directed elsewhere. We distinguished three types of covert-orienting shifts. "Reflexive Orienting" (RO) follows a flash occurring randomly to the left or right of fixation. This flash is unpredictive of the locus of the subsequent TS, yet it elicts rapid orienting (Posner, 1980). "Learned (prediction-generated) Orienting" (LO) follows a centrally-presented arrow indicating, with 0.8

probability, the locus of the subsequent TS. Having learned the informativeness of the arrow, the subject uses it to anticipate the TS (Posner, 1980). "Voluntary Orienting" (VO) occurs when a subject complies with a centrally-presented, symbolized request to shift his orientation to one locus. The direction of the request is not predictive of the locus of the subsequent TS, yet a cooperative subject is easily able to comply (Welford, 1973).

In the present project (Noonan, 1986), separateness of the mechanisms underlying these three processes was hypothesized. In a series of nine experiments, the characteristics of each mechanism were examined separately but under comparable conditions, and in three additional experiments the functional independence of each from the others was tested during simultaneous activation.

Subjects. The same twelve volunteers served as subjects for all experiments.

Methods. In all experiments the subject faced a video screen on which five squares appeared in a horizontal row. Visual fixation was maintained in the center, and the principal task was to respond rapidly with a manual key-press to the TS (a 17-msec "X") appearing at any time in any square. On each trial, the TS was preceded by a stimulus designed to engage one of the three mechanisms. This mechanism-engaging stimulus (MES) varied randomly in direction (Left or Right) across trials, and varied in type (RO flash, LO arrow, VO symbol) among experiments.

Results. 1. Variation of the stimulus-onset asynchrony (SOA) between the MES and TS (50, 100, 300, 750, 1000, 1500 msec) revealed striking differences in time course of operation. The minimal effective latencies for Reflexive Orienting, Learned Orienting, and Voluntary Orienting were 50, 100 and 300 msec, respectively; and the latencies to maximal effect were 50, 300, and 750 msec respectively.

2. Reflexive Orienting, but not Learned or Voluntary Orienting, was succeeded by a marked rebound effect, flash-TS SOAs 300 msec or longer producing slower RTs at cued than at counter-cued loci.

3. With SOA kept fixed at the previously-determined latency to maximal effect, Learned and Voluntary Orienting continued to be elicitable. By contrast, Reflexive Orienting (but not its long-latency rebound effect) disappeared. This is strongly reminiscent of the habituation of the classic orienting response (OR) to a repetitive stimulus.

4. When activated singly with bidirectional mechanism-engaging stimuli (e.g., double-headed arrow) designed to elicit orienting to both sides simultaneously, neither Learned nor Voluntary Orienting (nor the rebound effect of Reflexive Orienting), could be divided; instead the effect was diffused across the entire array. (Reflexive Orienting itself had habituated by this point.)

5. However, when each type of orienting was tested during

simultaneous engagement with each of the other two, Learned Orienting, Voluntary Orienting, and the after-effect of Reflexive Orienting proved able to vary in direction independently of the others. That is, the RT effect of each occurred as readily on the right or left regardless of whether either of the other types of orienting was simultaneously engaged to the left or right. Their effects simply added and subtracted without interaction.

Conclusions. Both the distinctiveness of their characteristics (time course, after-effect) and the fact that, while no single mechanism by itself could be divided, any two different types could move to the left and right simultaneously, indicate a separateness and independence of underlying neural mechanisms. Our results suggest that visuospatial attention is better conceptualized as a class of phenomena than as a single entity.

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